UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/515,348	02/29/2000	Christopher A. Spence	F0039	2076

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EXAMINER
WERNER, BRIAN P

ART UNIT	PAPER NUMBER
2621	

DATE MAILED: 02/25/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 10/03)

	Application No.	Applicant(s)
Office Action Summary	09/515,348	SPENCE, CHRISTOPHER A.
	Examiner	Art Unit
	Brian P. Werner	2621

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE <u>3</u> MONTH(S) FROM
THE MAILING DATE OF THIS COMMUNICATION.
- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on <u>01 December 2003</u>.

2a)☒ This action is **FINAL**.   2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) <u>1-20</u> is/are pending in the application.

    4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) <u>1-20</u> is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on <u>01 December 2003</u> is/are: a)☒ accepted or b)☐ objected to by the Examiner.

    Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

    Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

    a)☐ All b)☐ Some * c)☐ None of:

      1.☐ Certified copies of the priority documents have been received.

      2.☐ Certified copies of the priority documents have been received in Application No. _____.

      3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

    * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1)☒ Notice of References Cited (PTO-892)

2)☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3)☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
    Paper No(s)/Mail Date _____.

4)☐ Interview Summary (PTO-413)
    Paper No(s)/Mail Date. _____ .

5)☐ Notice of Informal Patent Application (PTO-152)

6)☐ Other: _____.

DETAILED ACTION

1.   This Office Action is responsive to the amendment received on December 1,

2003. The previous objections and 112 rejections are withdrawn. Claims 1-20 remain

pending.

Drawings

2.   The corrected or substitute drawings (i.e., figures 8, 10 & 11) were received on

December 1, 2003. These drawings are acceptable to the examiner.

Claim Rejections - 35 USC § 102

3.   The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that

form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

4.   Claims 1-3, 7-9, 13-20 are rejected under 35 U.S.C. 102(e) as being anticipated

by Pierrat et al. (US 6,091,845 A). The rejection is repeated from the previous Office

Action, with modifications appearing in **bold.**

Regarding independent claim 1, Pierrat discloses a method of analyzing a wafer

manufacturing process ("semiconductor devices ... detecting defects introduced during

the photolithography process" at column 1, lines 5-7; "wafers" at column 1, line 18)

comprising:

imaging a portion of a mask used in the wafer structure formation process (figure

1, numeral 130 and figure 3, numeral 230); and

simulating lithographic processing (figure 1, numeral 180 and figure 3, numerals

240, 250 and 260) using data received from or derived from the imaging of the portion

of the mask (as seen in figures 1 and 3, the simulation directly uses the image of the

mask), thereby obtaining a simulated wafer structure (e.g., "simulated image" at column

5, line 22 comprises simulated structure, such as "elevation data" at column 5, line 56

and "sidewalls" at column 6, line 5); **and**

evaluating the portion of the mask by comparing the simulated wafer

structure with a desired wafer structure (figure 3, numeral 270; the simulated

wafer structure at numeral 260 is compared with design data at numeral 210, and

design data represents the desired wafer structure; the claim is open ended, and

does not preclude intermediate processing such as the processing of numerals

255 and 265).

Regarding claim 2, the method further comprises comparing (figure 3, numeral

270) the simulated structure (i.e., figure 3, numeral 260) to a second simulated structure

(figure 3, numeral 265; **Note: the claim does not absolutely require a second,**

entirely different comparing step; thus, the fact that the design data at figure 3,

numeral 210 is simulated at numeral 265 before comparison meets the claimed

requirement; Should applicant wish to recite an entirely different step of

comparing, the following language is suggested: "further comprising a second

comparing step of comparing the simulated wafer structure to a second

simulated wafer structure").

Regarding claim 3, the second simulated structure uses mask design data (figure

3, numeral 210).

Regarding claim 7, a same simulation method is used (figure 3, the same

convolution and resist simulations are used; i.e., refer to numerals 250, 255, 260 and

265; Additionally, a separate embodiment is disclosed at figure 4, where the exact same

simulations are performed in parallel, as depicted by numerals 230-262).

Regarding claim 8, the first and second simulations are aerial simulations (the

Pierrat simulations are aerial simulations; e.g., an "aerial image measurement system"

at column 5, line 8 is used to capture the mask image from which the aerial simulation is

performed; the "simulation program logic is written in the C programming language" at

column 6, line 16).

Regarding claim 9, a simulation step is applied to the imaged data (i.e., figure 3,

numeral 240), where this step is not applied to the mask data (as depicted in figure 3).

Thus, the overall simulation processes of the mask data and the imaged data are

different.

Regarding claim 13, a SEM is used to capture the mask image ("SEM" at column

5, line 6).

Regarding claim 14, the SEM data is transformed into computer readable data (i.e., an electron image is transformed into the computer readable format required by the simulator; stated another way, a computer cannot manipulate an electron image direction, thus there must be some transformation of the electron image into a format required by the simulator).

Regarding claims 15 and 16, image analysis ("analyzes" at column 6, line 6) and scaling ("pixel erosion" at column 8, line 67; such an erosion algorithm reduces the size of a feature by eroding it away) of the data are performed.

Regarding claim 17, optical data is transformed into numerical computer data as depicted in figure 1 (i.e., light from 110 is passed through mask 161 and converted by sensor 130 to computer readable data).

Regarding dependent claim 18, an aerial image simulation program is disclosed (the Pierrat simulation is an aerial simulation; e.g., an "aerial image measurement system" at column 5, line 8 is used to capture the mask image from which the aerial simulation is performed; the "simulation program logic is written in the C programming language" at column 6, line 16).

Regarding dependent claim 20, the simulating includes simulating the developed resist image ("elevation data" at column 5, line 56 and "sidewalls" at column 6, line 5, both of which correspond to the "resist layer" at column 5, line 62, are simulated using "algorithms which emulate the behavior of resist material" at column 5, line 65).

Regarding claim 20, the simulating uses an aerial image microscope system (an "aerial image measurement system" at column 5, line 8 is used to capture the mask

image from which the aerial simulation is performed; given that the structures of the

mask being captured by Pierrat are extremely small, one of ordinary skill would

understand that the "aerial image measurement system" is a microscope system).

Claim Rejections - 35 USC § 103

5.   The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all

obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set
> forth in section 102 of this title, if the differences between the subject matter sought to be patented and
> the prior art are such that the subject matter as a whole would have been obvious at the time the
> invention was made to a person having ordinary skill in the art to which said subject matter pertains.
> Patentability shall not be negatived by the manner in which the invention was made.

6.   Claims 10 and 11 are rejected under 35 U.S.C. 103(a) as being unpatentable

over the combination of Pierrat et al. (US 6,091,845 A) and Sheng (US 6,477,265 A).

Pierrat discloses generating first and second simulated structures as described

above, whereby the structures are aligned and compared for defects (figure 1, numeral

140 and figure 3, numeral 270).

Regarding claims 10 and 11, Pierrat does not disclose displaying the first and

second simulated structures on a display screen, at least partially overlapping one

another.

Sheng discloses a photolithographic inspection system (Abstract, line 2),

comprising the comparison of two image images to detect differences that are defects

(figure 5; "defect detection" at column 3, line 56), wherein Sheng teaches displaying the

first and second images on a display screen, at least partially overlapping one another

("image display 44 displays the superimposed image" at column 3, line 41).

It would have been obvious at the time the invention was made to one of ordinary skill in the art to superimpose and display the first and second simulated images of Pierrat, as taught by Sheng, so that in fulfilling Pierrat's requirement for defect inspection, the images of Pierrat "can easily be inspected for defects" (Sheng, column 2, line 21, line 25, and column 3, line 61).

7.   Claim 12 is rejected under 35 U.S.C. 103(a) as being unpatentable over the combination of Pierrat et al. (US 6,091,845 A) and Sheng (US 6,477,265 A) as applied to claim 11 above, and further in combination with Fiekowsky (US 6,263,292 B1).

The Pierrat and Sheng combination as applied to claim 11 discloses comparing images of two simulated structures for differences due to defects.

The Pierrat and Sheng combination does not disclose providing a user with an option of selecting a figure of merit by which critical dimension variations between the simulated structures are to be calculated.

Fiekowsky discloses a mask inspection system (figure 1; "mask" at column 10, line 58), comprising providing a user with an option of selecting a figure of merit by which critical dimension variations between the images are to be calculated ("identifying and measuring a variety of features such as defects and line widths" at column 11, line 30; "user region of interest" at column 11, line 42; "the operator is able to enter review mode and to quickly surround spot 71 with a rough user region of interest 72 indicating the region that the user wishes to analyze and measure" at column 11, lines 47-50).

It would have been obvious at the time the invention was made to one of ordinary skill in the art to modify the Pierrat and Sheng combination as applied to clam 11, by providing a user selected figure of merit (e.g., "line widths ... heights" at column 4, Fiekowsky lines 21-22; "diameters" at Fiekowsky column 3, line 64) as taught by Fiekowsky, in order to provide "a measurement tool that provides an objective, practical and fast method for accurate sizing of mask features found with an automatic inspection tool" (Fiekowsky, column 3, lines 61-64).

8.   Claims 4-6 are rejected under 35 U.S.C. 103(a) as being unpatentable over the combination of Pierrat et al. (US 6,091,845 A) and Fiekowsky (US 6,263,292 B1).

Pierrat, as applied to claims 1-3 above, discloses comparing images of two simulated structures for differences due to defects.

Regarding claim 4, Pierrat does not disclose providing a user with an option of selecting a figure of merit by which critical dimension variations between the simulated structures are to be calculated.

Regarding claim 5, line width is not disclosed.

Regarding claim 6, percentage of a difference in area is not disclosed.

Regarding claims 4 and 5, Fiekowsky discloses a mask inspection system (figure 1; "mask" at column 10, line 58), comprising providing a user with an option of selecting a figure of merit by which critical dimension variations between the images are to be calculated ("identifying and measuring a variety of features such as defects and line widths" at column 11, line 30; "user region of interest" at column 11, line 42; "the

operator is able to enter review mode and to quickly surround spot 71 with a rough user

region of interest 72 indicating the region that the user wishes to analyze and measure"

at column 11, lines 47-50).

It would have been obvious at the time the invention was made to one of ordinary

skill in the art to modify Pierrat, by providing a user selected figure of merit (e.g., "line

widths ... heights" at column 4, Fiekowsky lines 21-22; "diameters" at Fiekowsky column

3, line 64) as taught by Fiekowsky, in order to provide "a measurement tool that

provides an objective, practical and fast method for accurate sizing of mask features

found with an automatic inspection tool" (Fiekowsky, column 3, lines 61-64).

Regarding claim 6, percentage of a difference area is one of many measures of

differences between features that is well known, and would have been obvious to one of

ordinary skill in the art in order to determine the extent of the difference.

New Grounds of Rejection

9.   Claim 1 is rejected under 35 U.S.C. 103(a) as being unpatentable over the

combination of Garza et al. (US 6,081,659 A) and Pierrat et al. (US 6,091,845 A).

Regarding claim 1, Garza discloses a method comprising:

imaging a portion of wafer structure produced by a mask used in the wafer

structure formation process (figure 7, numeral 216); and

evaluating the mask by comparing the wafer structure with a desired wafer

structure (figure 7, numeral 218-219).

In summary, Garza analyzes a mask by creating an actual pattern of wafer structure in a wafer using the mask (i.e., as depicted in figure 6), takes an image of the wafer structure, and then compares the image with data representing an ideal pattern.

Garza does not image the mask directly, and Garza does not simulate the lithographic processing using data received from or derived from the imaging of the portion of the mask.

Pierrat, as described above, teaches creating a simulated image of wafer structure from an image of the mask, and comparing the simulated image design data (i.e., figure 3).

It would have been obvious at the time the invention was made to one of ordinary skill in the art to modify the Garza system to simulate wafer structure from a mask image as taught by Pierrat, instead of actually creating and imaging the wafer structure, to obviate the costs associated with transferring a defective mask pattern to an actual wafer ("costly to repair" and "discarded" at Pierrat, column 2, lines 38-42), by anticipating the mask defects "before resist processing begins" (Pierrat column 2, line 44).

Response to Arguments

10.   Each of the remarks and/or arguments filed with the aforementioned amendment

have been considered:

Drawings:

Summary of Applicant's Remarks: Figures 8, 10 and 11 have been amended.

Examiner's Response: The drawing changes are acceptable.

Specification:

Summary of Applicant's Remarks: Various sections of the specification have

been amended to address possible trademarks, as well as to conform to the drawing

changes. New matter has not been entered.

Examiner's Response: The specification changes are acceptable.

Claim 112 rejections:

Summary of Applicant's Remarks: Claim 6 has been amended.

Examiner's Response: The previous 112 rejection has been withdrawn.

Prior Art Rejections:

Summary of Applicant's Remarks: "Pierrat does not disclosed evaluating the

portion of the mask by comparing a simulated wafer structure (image) to a desired wafer

structure" at response page 14.

Examiner's Response: The examiner disagrees. Pierrat teaches the evaluation of a

mask by comparing the simulated wafer structure with a desired wafer structure at

figure 3, numeral 270. That is, the simulated wafer structure at numeral 260 is

compared with design data at numeral 210, and design data represents the desired

wafer structure. Given that the claim is open ended, it therefore does not preclude

intermediate processing such as the processing at numerals 255 and 265. Pieratt's

evaluation at numeral is a comparison of a simulated wafer structure indirectly with its

original design data; which is representative of the desired structure.

Note: Claim 2 further requires a comparing of the simulated structure to a

second simulated structure. The claim does not absolutely require a second, entirely

different comparing step. Thus, the fact that the design data at figure 3, numeral 210 is

simulated at numeral 265 before comparison meets the claimed requirement.

The 103 Combinations:

Regarding each of the claims rejected under 103, the arguments related to

Pierrat reference are repeated, and the various combinations are not further argued per

se.

Conclusion

11.   **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time

policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE

MONTHS from the mailing date of this action. In the event a first reply is filed within

TWO MONTHS of the mailing date of this final action and the advisory action is not

mailed until after the end of the THREE-MONTH shortened statutory period, then the

shortened statutory period will expire on the date the advisory action is mailed, and any

extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of

the advisory action. In no event, however, will the statutory period for reply expire later

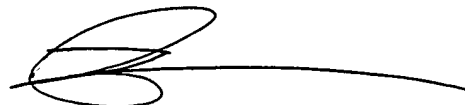than SIX MONTHS from the mailing date of this final action.

12.   Any inquiry concerning this communication or earlier communications from the

examiner should be directed to Brian P. Werner whose telephone number is 703-306-

3037. The examiner can normally be reached on M-F, 8:00 - 4:30.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's

supervisor, Leo H. Boudreau can be reached on 703-305-4706. The fax phone number

for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the

Patent Application Information Retrieval (PAIR) system. Status information for

published applications may be obtained from either Private PAIR or Public PAIR.

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For more information about the PAIR system, see http://pair-direct.uspto.gov. Should

you have questions on access to the Private PAIR system, contact the Electronic

Business Center (EBC) at 866-217-9197 (toll-free).

Brian Werner
Primary Examiner
Art Unit 2621
February 18, 2004

BRIAN WERNER
PRIMARY EXAMINER